Northwestern Division - US Army Corps of Engineers
ANADROMOUS FISH EVALUATION PROGRAM
FY 2004 RESEARCH SUMMARIES

Bypass Systems (BPS)

1. BPS-P-00-14
   B2 FGE

2. BPS-P-00-15
   Evaluation of Modified Extended-Length Submersible Bar Screens at John Day Dam

3. BPS-P-03-NEW
   Evaluation of full-flow PIT-tag interrogation systems at Bonneville and John Day Dams.

Spill Evaluation (SPE)

1. SPE-P-02-1
   Survival of Juvenile Salmonids at Bonneville Dam.

2. SPE-P-00-7 (formerly MPE-98-4)
   Evaluation of the John Day Dam Spillway as a Juvenile Salmon Passage Route.

3. SPE-P-00-8
   Juvenile Salmonid Survival Studies at The Dalles Dam

4. SPE-P-04-New
   Feasibility of Reducing Indirect Mortality/Predation of Juvenile Salmonids entering the Tailrace of The Dalles Dam

Surface Bypass Evaluation (SBE)

1. SBE-P-00-7 (formerly MPE-P-96-2)
   Evaluations and Studies of Fish Passage Efficiency at Bonneville Dam.

2. SBE-P-03-1 NEW
   Development of Fish Sampling Capability for Evaluation of Surface Flow Bypass (SFB).

3. SBE-P-03-NEW
   Linking Juvenile Salmonid Behavior with Hydraulic Variables

4. SBE-P-0017
   Studies of Surface Flow Bypass at The Dalles Dam.

5. SBE-P-03-NEW
   Studies of Surface Flow Bypass at John Day Dam.

Adult Studies (ADS)

1. ADS-00-1
   Evaluation of Adult Salmon and Steelhead Fallback at Snake and Columbia River Dams

2. ADS-00-2
   Evaluation of Adult Salmon and Steelhead Delay at Snake and Columbia River Dams

3. ADS-00-4
   Investigation of Straying in Adult Salmon and Steelhead.

4. ADS-00-5
   Temperature and dissolved gas exposure of adult salmon and steelhead migrants and the effects of water quality on survival and reproductive success.

5. ADS-00-6
   Evaluation of Kelt Passage through Columbia and Snake River Dams.

6. ADS-P-00-8 (formerly MPE-99-1)
   Development of Alternative Means to Pass Adult Pacific Lamprey Around Dams

7. ADS-00-13
   Effects of Dam Passage on Survival and Reproductive Fitness of Adult Salmon and Steelhead

8. ADS-00-14 (*Placeholder)*
   Adult Salmonid Behavior and Passage Routes Within Adult Fishways Associated with the Adult PIT Tag Evaluations Program.

9. ADS-02-16 *(Placeholder awaiting a low run year or decision on suitable management action)*
   Evaluation of Sea Lion Predation Below Bonneville Dam

10. ADS-04-NEW
    White Sturgeon Passage at Lower Columbia River Dams.

11. ADS-P-04 - NEW
    Evaluation of John Day Dam South Fish Ladder Modifications

Bull Trout Studies (BTS)

1. BT-04-NEW
   Bull trout passage at lower Columbia River dams.

Estuary Studies (EST)

1. EST-02-01
   A Study To Estimate Salmonid Survival Through The Columbia River Estuary Using Acoustic Tags

2. EST-02-02
   Estuarine Habitat And Juvenile Salmon – Current And Historic Linkages In The Lower Columbia River And Estuary

3. EST-02-03
   Evaluation Of The Relationship Among Time Of Ocean Entry, Physical, And Biological Characteristics Of The Estuary And Plum Environment And Adult Return Rates.

4. EST-04-NEW
   Evaluate Adult Salmon Habitat Use in the Columbia River Estuary and Plume

5. EST-04-NEW
   Evaluating cumulative ecosystem response to restoration projects in the Lower Columbia River and Estuary

Northwestern Division- Corps of Engineers
ANADROMOUS FISH EVALUATION PROGRAM
RESEARCH SUMMARY

STUDY CODE: BPS-P-00-14

TITLE: B2 FGE

FISH PROGRAM FEATURE: CRFMP-Bonneville-Powerhouse 2 FGE

BIOP MEASURE: RPA 67

The current downstream migration system at the Second Powerhouse consists of a submersible traveling screen (STS) system designed to guide juvenile salmonids up into a gatewell slot bypassing the turbines to a release point approximately 2 miles downstream of the project. After initial start up in the early 1980's, the bypass system was tested and found to have low guidance efficiencies (FGE) for all target fish. As part of an extensive multi-year research and development program, turbine intake extensions, streamlined trashracks, and lowered STS' were installed which significantly improved FGE for spring migrants. However, FGE for yearling and subyearling migrants remains unacceptably low, 45-60% and 20-25% respectively. In 1999, we reviewed past work, developed alternatives, and prepared out-year plans and cost estimates. The resulting program uses a phased approach to addressing hypotheses presented by the 1999 work. Initial effort will focus on the intake environment. For FY00, we measured vertical distribution upstream and within two intakes, and also estimated FGE across all units. We also initiated a hydraulic modeling program to develop a prototype intake screen system. In both 2001 and 2002, we field-tested a prototype screen system at Powerhouse 2 in units 15 & 17 and found significant FGE improvement for both spring and summer migrants. However, we also evaluated gap loss through top of the screen in modified and unmodified units in 2002 and found significant loss of fish through the gap. In FY03, we continue to investigate gap loss in both a modified and unmodified unit during both spring and summer. A new VBS design and well as a gatewell cleaning system is scheduled for installation during the winter of 2003-04 and will require additional biological research to be conducted in FY04. Once full biological testing is completed, including gap loss evaluations, and the FGE effects of the corner collector are better understood, the Region will decide whether to extend the modifications to other PH2 units.

OBJECTIVES:

1. Evaluate the effectiveness of a prototype intake screen system for both spring and summer juvenile salmonid migrants:
    a. Evaluate FGE for yearling and sub-yearling chinook, sockeye, coho, and steelhead and determine if modified units improve FGE.
    b. Determine condition of fish collected from a gatewell of the prototype unit.
    c. Compare survival and condition between different passage routes: prototype gatewell, collection channel, and STS gatewell with the aid of PIT tags.
    d. Determine orifice passage efficiency.
    e. Determine gatewell retention time.
    f. Evaluate gap loss in both modified and un-modified units.
    g. Determine the difference in gap loss metrics between fyke net and acoustic camera.
2. Evaluate the FGE and improvements at Bonneville 2 with improvements inclusive of the B2 Corner Collector.

SCHEDULE: 2003 – 2006

Northwestern Division- Corps of Engineers
ANADROMOUS FISH EVALUATION PROGRAM
RESEARCH SUMMARY

STUDY CODE: BPS-P-00-15

TITLE: Evaluation of Modified Extended-Length Submersible Bar Screens at John Day Dam

FISH PROGRAM FEATURE: CRFMP-John Day Dam-Extended Screens

BIOP MEASURE: RPAs 73 and 98.

Fish guidance efficiency (FGE) of subyearling chinook salmon using standard-length traveling screens (STS) at John Day Dam has been estimated to be approximately 26%. In 1996, prototype extended-length submersible bar screens (ESBS) were evaluated for FGE, orifice passage efficiency (OPE), and fish condition. Significant improvements in FGE and OPE were documented during the ESBS evaluation. FGE for subyearling chinook was estimated to be near 60%, OPE was in excess of 97%, and descaling of fish dipped out of the test gatewell was less than 1.5%. However, significant damage to the ESBS' occurred after 30 days of operation, requiring the Corps to modify the structural design of the screens. After modification, the screens were again evaluated in 1999 to verify the 1996 FGE/OPE/fish condition results. PIT-tagged juvenile salmonids released into the test unit gatewell and collected at the John day Dam smolt monitoring facility incurred high mortality (up to 42%) relative to a standard gatewell, presumably due to gatewell hydraulic conditions. As a result, the 1999 summer FGE/OPE evaluation was suspended. For the remainder of 1999 and through 2002, a new vertical barrier screen (VBS) design was developed along with a gatewell flow control device. Additionally, 1/8 inch spaced bar screen on the ESBS (and VBS) was replaced with 1.75 mm spaced bar screen to help reduce impingement of salmonid fry and juvenile lamprey on the screens.

Biological testing of the new system was conducted in 2002. During spring testing, mean FGE was 80.0% for yearling chinook salmon and 72.2% for sockeye salmon; coho salmon and steelhead were not present in large enough numbers during the abbreviated test season for meaningful statistical calculations. Mortality of PIT-tagged yearling chinook released during FGE tests was low, at 0.1, 0.2, and 0.3% for the ESBS slot, STS slot, and the collection channel, respectively. Mean yearling chinook salmon descaling was 4% for the ESBS and 6% for the STS during the FGE tests. During summer testing, mean FGE was 63.8% for subyearling chinook salmon. Mortality of released PIT tagged subyearling chinook salmon was also low, at 0.1, 0, and 0.5% for the ESBS slot, STS slot, and the collection channel, respectively. Mean subyearling chinook salmon descaling was 1% for the ESBS and 2% for the STS. Results from 2002 biological testing are encouraging however, after only a few weeks of operation, small holes developed in the VBS panels. Cause of the holes is unknown however; it is suspected that excess vibration may be causing individual bars to crack and break off. The Corps is currently in the process of replacing the existing Johnson bar screen panels with heavier-gauge, Hendrix bar screen material. Pending replacement of the VBS screen material an evaluation of gatewell fish condition and survival will be conducted in 2004.

OBJECTIVES: (*Placeholder pending completion of vertical barrier screen bar screen replacement)*

1. Determine condition of salmonid fry passing through a prototype gatewell.
2. Determine condition and survival of PIT-tagged yearling and subyearling chinook salmon passing through a prototype gatewell.

SCHEDULE: 2004

Northwestern Division - Corps of Engineers
ANADROMOUS FISH EVALUATION PROGRAM
RESEARCH SUMMARY

STUDY CODE: BPS-P-03-NEW

TITLE: Evaluation of full-flow PIT-tag interrogation systems at Bonneville and John Day Dams.

FISH PROGRAM FEATURE: CRFMP - Bonneville and John Day

BIOP MEASURE: RPA 87

Presently, juvenile PIT-tag interrogation capabilities at Bonneville and John Day dams are only available after bypassed juveniles pass through multiple dewatering systems that reduce collection channel flow down to 2-3 cfs. Normally, these bypass systems initially dewater the collection channel flow to approximately 30-50 cfs for ease of passing the flow, then dewater further to 2-3 cfs for PIT-tag interrogation and hands-on fish condition sampling. It is thought that this secondary dewatering from 30-50 cfs down to 2-3 cfs may cause additional injury and/or stress to juvenile migrants passing through the bypass system. With the recent implementation of ISO 134.2 kHz technology and improvements in interrogation electronics, PIT-tag detections can now be made over much greater ranges. Developing a PIT-tag interrogation system that would preclude the need for secondary dewatering (from 30-50 to 2-3 cfs) is one alternative that may help reduce injury and/or stress in bypassed juveniles. Recently, preliminary work has been initiated to develop "full-flow" PIT-tag detection at McNary Dam. Pending the outcome of this work, further development of this technology should be pursued to improve the condition of bypassed individuals. Work in 2004 will be limited to conducting site evaluations at John Day and/or Bonneville to determine the feasibility of implementing this technology at these sites. Following a favorable site feasibility evaluation in 2004, design and construction will be initiated. A post-construction evaluation of the efficiency and performance of the system will be performed following construction.

OBJECTIVES:

1. Conduct a site evaluation of John Day to determine feasibility, optimal location, and configuration of a full-flow PIT-tag interrogation system.
2. Conduct a site evaluation of Bonneville to determine feasibility, optimal location, and configuration of a full-flow PIT-tag interrogation system.

SCHEDULE: 2003 - 2005

North Pacific Division -- Corps of Engineers
ANADROMOUS FISH EVALUATION PROGRAM
RESEARCH SUMMARY

STUDY CODE: SPE-P-02-1

TITLE: Survival of Juvenile Salmonids at Bonneville Dam.

FISH PROGRAM FEATURE: CRFMP - Bonneville

BIOP MEASURE: Per the National Marine Fisheries Service, Biological Opinion RPAs 64 (MGR), 66 (B2 CC), & 82 (spill survival) the Portland District will be evaluating survival through all juvenile salmonid fish passage routes. With the completion of the new SFB Corner Collector at the second powerhouse, a thorough post construction survival program to evaluate project survival, and route specific survival data are necessary to further evaluate future fish passage programs and operations at the Bonneville project. Further, two routes at the first powerhouse will be evaluated (B1 MGR & I&T) for survival to assist in future planning efforts.

OBJECTIVES:

1. Obtain project and spillway survival for the entire Bonneville project (this may be dependent on releases from upstream projects) for spring (CH1 & Stld) and summer (CH 0) migrants.
2. Obtain route specific survival in the spring and summer (CH1, Stld, & CH0) for juveniles passing through the B2 JBS, B2 CC, and spillway, relative to each other and a downstream control (the summer test will occur between the B2 CC and B2 JBS with and without spill).
3. Obtain route specific survival estimates (possibly both direct and indirect) for spring and summer (CH1, Stld, & Ch0) juvenile salmonids passing through the B1 Ice and Trash Sluiceway.
4. Obtain route specific spring (CH1 & Stld) survival estimates for juvenile salmonids passing through a modified main unit (MGR) at Bonneville First Powerhouse.
5. Obtain route specific survival estimates (direct) for juvenile salmonids passing through the 7’ versus 14’ flow deflectors at the spillway.
6. Estimate project FPE during the March SCNFH release of subyearling chinook (2004 only).

SCHEDULE: 2004 – 2005

Northwestern Division- Corps of Engineers
ANADROMOUS FISH EVALUATION PROGRAM
RESEARCH SUMMARY

STUDY CODE: SPE-P-00-7 (formerly MPE-98-4)

TITLE: Evaluation of the John Day Dam Spillway as a Juvenile Salmon Passage Route.

FISH PROGRAM FEATURE: CRFMP-In-river Passage

BIOP MEASURE: RPAs 71, 73, 82, and 83

Spill patterns at the John Day Dam were developed during the 1980s to facilitate fish passage from the forebay and provide good downstream egress conditions. In 1998, the spill pattern was modified for the addition of new spillway flow deflectors. This new pattern was evaluated under BiOp required flows for both the spring and summer outmigrations. Spill effectiveness was high, forebay retention low, and tailrace egress relatively quick and direct. In 1999, 2000, and 2002 the effect of 24-hour spill on FPE, SPE, and forebay retention time was evaluated. For all three years, spring migrant FPE was not significantly different between 12 hour versus 24-hour spill, however FPE did differ significantly for summer migrants in 2000. In 2000 and 2002 survival was estimated at John Day using radio telemetry. The 2000 survival study results suggest that forebay delay does not affect survival. For both 12 and 24-hour spill treatments, there were no differences in survival rates from release at Rock Creek to last detection (passage) in the forebay. In addition, there was no correlation between survival rate and forebay residence time. Spillway survival rates from 2000 were high (~99%) for yearling chinook and steelhead passing during the 12-hour spill treatments in 2000. During 24-hour spill, however, survival rates were unacceptably low (94-91%). In 2002, project survival was higher for yearling chinook under the 24-hour spill treatment and lower for steelhead under the 24-hour spill treatment. No tests of significance were complete at the time of this draft. Factors that appear to be driving the survival estimates are very low turbine, and, under 60% night spill, JBS survival rates. In addition, steelhead survival was lower at the spillway during the day. In 2001 there was only limited spill at John Day Dam and most survival studies were delayed until 2002. The one objective completed in 2001 was a survival evaluation of fish passing the juvenile bypass system. Survival estimates for both spring and summer migrants fell well below the expected 98% mark. Tailrace egress information collected in 2000 and 2002 showed that fish entering the tailrace via the juvenile fish bypass outfall had slower egress from the tailrace than fish passing the spillway. In addition, bypassed fish had significantly longer tailrace residence times under the 60% nighttime spill condition compared the 30% day spill condition. Tailrace egress monitoring in 2002 for fish exiting the JBS at night revealed egress times for fish passing under the 60% night spill treatment to be double those of fish exiting under 30% night spill. These differences were statistically significant. In addition, fish exiting the JBS during 60% night spill moved in more of a northerly direction compared to fish exiting the JBS during 30% night spill. The summer study design was not met in 2002 due to lack of power demand. Therefore, we will repeat the 2002 12 vs. 24-hour spill test for summer migrants in 2003. The focus on 2003 spring research is on night spill optimization for project survival: 45% night spill will be compared to BiOp spill for FPE and project and route-specific survival. Results from 2003 will determine whether another year of research on spring spill optimization, summer 12 vs. 24-hour spill, or summer spill optimization is needed.

OBJECTIVES: (FY04 –Placeholder pending 2003 results).

1. Estimate spring and summer migrant project and route specific survival rates for two spill operations
   Ho: survival under BiOp spill = survival under alternative spill operation.
   Ha: Survival under BiOp spill < survival under alternative spill operation.
2. Estimate fish passage efficiency and spill passage efficiency for two spill operations.
3. Evaluate forebay retention time for fish passing the project under two spill conditions.
4. Monitor tailrace egress of fish passing the spillway and bypass system outfall under two spill operations.

SCHEDULE: 1999 - 2005

Northwestern Division - Corps of Engineers
ANADROMOUS FISH EVALUATION PROGRAM
RESEARCH SUMMARY

STUDY CODE: SPE-P-00-8

TITLE: Juvenile Salmonid Survival Studies at The Dalles Dam

FISH PROGRAM FEATURE: CRFMP-In-river Passage

BIOP MEASURE: RPA 68, 70, and 83

From 1997-2000, the National Marine Fisheries Service (NMFS) evaluated survival at The Dalles Dam using passive integrated transponder (PIT) tagged smolts. Their objective was to assess whether spillway passage survival under 64% spill was high (98%) and if not, determine whether lower spill rates would improve survival. Based on 1997-2000 survival results, NMFS found that percent spill affected survival, with 30% spill resulting in higher survival than 64%. In addition to spill level, NMFS found that survival for subyearling chinook was consistently higher at night than in the day. Previous study designs did not enable separation of day night versus spill pattern changes, but it was thought that the increased night survival was due to the juvenile spill pattern, which was only used at night. To evaluate the theory that smolt survival improves under the juvenile fish spill pattern, survival was evaluated using 40% spill, juvenile pattern for 24 hours per day during the 2000 juvenile migration. The 24-hour per day juvenile spill in 2000 proved highly effective at passing a large proportion of the juvenile migration over the spillway, with spill passage efficiency values similar to those seen at 64% spill in previous years. In addition, survival at 40% spill in 2000 was similar to survival measured under 30% spill in previous years. However, while survival is higher at the lower (30-40%) spill percentages, it is still unacceptably low for a primary passage route. In 2001, the scope of survival studies for The Dalles Dam spillway shifted from developing point survival estimates under various operating conditions, to identifying the causal mechanisms of mortality. Results from studies conducted in 2001-2003 suggest there is a direct effect on smolt survival and injury for fish passing through the stilling basin and that direct survival and injury appear to be influenced by lateral flow that passes along the stilling basin's length from south to north. A concurrent engineering study developed a solution to eliminate lateral flow in the stilling basin: lateral flow can be blocked by a longitudinal training wall that extends from the downstream spillway pier nose between bays 6 and 7 to the end sill. Balloon-tag studies were conducted in 2003 to determine the amount of spill per bay that can be discharged with minimal fish injury and mortality. Preliminary results suggest that for typical summer migrant river conditions, 40% of the total river discharge could be safely passed through Bays 1-6 with no measurable increase in fish injury or mortality. Pending results from the 2003 spring balloon tag test, this training wall will be constructed in 2003-04 and evaluated in 2004. Primary issues to address for the post-construction evaluation include the wall's effect on survival and injury rates for spillway passed fish, spillway and fish passage efficiency, and upstream adult fish passage.

OBJECTIVES (FY04):

1. Characterize Stilling Basin Hydraulic Conditions that Fish Experience During Spill Passage.
2. Estimate Direct + Indirect Survival Rates of Yearling Chinook, Steelhead / Sockeye, and Subyearling Chinook Passing the Project, Spillway, and Powerhouse. Project survival estimate 95% CI half-width = ± 4%.
3. Evaluate Juvenile Salmonid Travel Paths and Travel Time through the Stilling Basin.
4. Evaluate Tailrace Egress for Juvenile Salmonids that Pass Through the Spillway.
5. Estimate Direct Mortality (90% CI half-width = ±3%) and Injury Rates:
6. Estimate mortality and injury rates of balloon-tagged yearling chinook that pass the spillway.
7. Estimate the effect of per bay discharge on direct survival and injury rates for yearling chinook (Placeholder pending 03 results).
8. Estimate Fish Passage Efficiency (<4%, 95% CI half –width), Spillway Passage Efficiency, and Sluiceway Passage Efficiency.
9. Estimate Forebay Residence Times.

SCHEDULE: 1997 – 2005

Northwestern Division – Corps of Engineers
ANADROMOUS FISH EVALUATION PROGRAM
RESEARCH SUMMARY

STUDY CODE: SPE-P-04-New

TITLE: Feasibility of Reducing Indirect Mortality/Predation of Juvenile Salmonids entering the Tailrace of The Dalles Dam

FISH PROGRAM FEATURE: CRFMP - In-river Passage

BIOP MEASURE: RPAs 68 and 70

Results of recent (1997-2002) juvenile salmonid passage survival studies at The Dalles Dam (TDA), using several techniques (i.e. PIT tags, radio telemetry, and balloon tags) have provided some of the lowest passage survival estimates (averaging 93-91% project survival in 2002) in the Columbia River Basin. Survival estimates generated from PIT tag and radio telemetry studies include both direct and indirect mortality and balloon tag studies provide only direct mortality (and injury) estimates. Although questions still remain regarding the ratio of direct to indirect mortality, the indirect mortality is assumed to be significant especially for those fish passing the powerhouse and the south to mid spill bays. It is also assumed that the majority of this mortality is due to predation by northern pikeminnow (NPM) and smallmouth bass (SMB). The NPM Management Program has been effective at removing large numbers of pikeminnow on a broad systemwide basis, but locally at TDA, observations of NPM and SMB predation on juvenile salmonids appears to be intense especially during summer (August 2002 during balloon tag studies). Recapture rates of balloon tagged fish were so low, due to predation, that survival estimates could not be generated. Radio telemetry studies were done on NPM and SMB in 2002, and this information indicates that both predators are concentrated mostly in the Basin islands in the spring but in the summer NPM move are fairly evenly dispersed in the island areas as well as the sluiceway, powerhouse, and nav lock areas. SMB in summer stayed mostly in the Basin islands area (51%), but the nav lock (19%) and powerhouse (17%) areas were also used. Area-use patterns and direct sampling data will be useful in targeting predator removal if it proves feasible.

OBJECTIVES: (FY04):

1. Define the problem.
    a. Determine the relative significance of smallmouth bass predation on smolts to northern pikeminnow predation in The Dalles tailrace.
    b. Describe smallmouth bass population characteristics that could be used to assess a predator management program and collect baseline (before) data.
2. Evaluate management alternatives.
    a. Conduct a literature review to assess smallmouth bass management alternatives.
    b. Test preferred alternative(s)
3. Develop and execute a small mouth bass management program including biological monitoring for predator response and reduction of juvenile salmonid mortality.

SCHEDULE: 2003 – 2007

North Pacific Division - Corps of Engineers
ANADROMOUS FISH EVALUATION PROGRAM
RESEARCH SUMMARY

Study Code: SBE-P-00-7 (formerly MPE-P-96-2)

TITLE: Evaluations and Studies of Fish Passage Efficiency at Bonneville Dam.

FISH PROGRAM FEATURE: CRFMP - Bonneville – Surface Flow Bypass (SFB).

BIOP MEASURE: Reasonable and Prudent Alternative (RPA) 66 directed the COE to design and construct a permanent corner collector at the second powerhouse. The post construction study will also support the planned post construction survival study, and provide information on fish distribution and passage efficiency necessary for final Bonneville operational. Additionally, this research activity will support the Bonneville Decision Document (RPA 97) planning process in determination of next steps to improve passage at the first powerhouse.

OBJECTIVES:

1. Estimate the proportion of juvenile salmon passing through each route at the first powerhouse, second powerhouse, and spillway. This will include FPE for spring and summer migrants at large, as well as species specific FPE (CH1, Stld, & CH0).
2. Determine mean densities of juvenile salmon for each depth bin, horizontal bin, and transect; by day/night, season.

SCHEDULE: 2004 – 2005

NOTE: Although this is a post construction evaluation of the B2 CC, the Bonneville Decision Document has dictated the construction of the B2 SFB Corner Collector and prioritization of B2 as the priority powerhouse. Questions concerning which direction to take on improvements to B1 (SFB versus ESBS) are on hold pending additional information on sluiceway efficiency and survival through B1. Future direction at B1 will be dependent on the collection of additional biological information at those routes.

Northwestern Division- Corps of Engineers
ANADROMOUS FISH EVALUATION PROGRAM
RESEARCH SUMMARY

Study Code: SBE-P-03-1 NEW

TITLE: Development of Fish Sampling Capability for Evaluation of Surface Flow Bypass (SFB).

FISH PROGRAM FEATURE: CRFMP - Bonneville, The Dalles, and John Day - Surface Flow Bypass.

BIOP MEASURE: RPA 66

The Bonneville 2nd powerhouse (B2) corner collector currently is scheduled for completion in 2004. It is expected that significant numbers of downstream migrants will be using the corner collector as opposed to passing through the B2 juvenile bypass system (JBS). Consequently, the number of PIT-tagged fish passing the B2 JBS and used to generate reach survival estimates from McNary through Bonneville Dam will be significantly reduced. Currently, a joint funded program between BPA and the COE is underway to determine the feasibility of detecting PIT-tagged fish that pass through the corner collector in an effort to obtain adequate sample sizes needed to generate the reach survival estimates. Existing PIT-tag technology has not been applied to a system with the dimensions of the new corner collector flume. It is unlikely that the detection field will cover the entire cross-sectional volume of the flume. Therefore, in order to better understand the detection field necessary to detect adequate numbers of PIT-tagged fish passing the flume, information on fish distribution as they pass through the flume is needed. The current schedule calls for prototype testing to begin in FY04, and if feasible, full installation will continue into FY05.

OBJECTIVES:

1. Evaluate a large prototype diameter, low frequency, and submersible PIT detector for use in the Bonneville 2 sluice chute. Data to be collected from pending research should include:
   a. Horizontal and Vertical distribution of juvenile salmonids passing through the sluice chute for spring and summer migrants.
   b. Fish density throughout the passage season (diel to be included) spring vs. summer.
   c. Fish alignment in flow during sluice chute passage.
   d. Juvenile salmonid forebay entrance depth. Data needs to resolve whether or not fish entrance elevations correspond to travel depths and regions in sluiceway.
2. Construct and deploy a system capable to detect horizontal and vertical distribution of juvenile salmonids using the newly constructed corner collector. Estimate numbers of fish using the system and their diel passage patterns. Characterize the difference passage behavior or tendencies for various species both spring and summer.
3. Investigate and initiate study using light emitting transmitters to determine the vertical and horizontal distribution of fish passing the B2 corner collector.

SCHEDULE: 2004 – 2005

Northwestern Division - Corps of Engineers
ANADROMOUS FISH EVALUATION PROGRAM
RESEARCH SUMMARY

STUDY CODE: SBE-P-03-NEW

TITLE: Linking Juvenile Salmonid Behavior with Hydraulic Variables

FISH PROGRAM FEATURE: CRFMP – Surface Flow Bypass

BIOP MEASURE: RPAs 85 and 86.

The U.S. Army Corps of Engineers' surface flow bypass (SFB) program was initiated in 1994 to "develop and evaluate surface bypass and collection prototype concepts that will lead, if justified by prototype test results, to permanent systems for improving survival of juvenile salmon". The initiation of this program was prompted by the apparent effectiveness of a surface bypass system at Wells Dam and sluiceways at Bonneville, Ice Harbor, and The Dalles dams. Passage effectiveness at these sites warranted investigation of surface flow bypass as a means to safely and efficiently bypass juvenile salmonids at Columbia and Snake River dams. Subsequently, prototype surface collectors were evaluated at both Bonneville, from 1998 to 2000, and Lower Granite, from 1994 to 2000. Results of these evaluations differ to some extent and suggest that the collection or passage efficiency of these surface flow bypasses may be determined by juvenile salmonids' behavioral response to hydraulic conditions that are not thoroughly understood. Additionally, the vertical distribution of juvenile salmonids entering forebays may also play a role on passage efficiency of SFB systems. There is evidence that suggests a relatively high percentage of downstream migrants may encounter entrances to bypass systems, yet are reluctant to enter and pass, presumably due to the hydraulic signature near bypass entrances. To date, some effort has been aimed at evaluating the efficacy of using artificially induced turbulence to guide juvenile salmonids to bypass entrances. Results from this effort are encouraging, however the mechanism is poorly understood. Additional work has focused on correlating fish travel paths with computational fluid dynamic (CFD) model outputs. This additional work has preliminarily identified hydraulic variables that appear to correlate well with fish swim path selection. The concept, developed using CFD model outputs and field data on individual fish movements, needs to be further evaluated at alternate sites with varying hydraulic signatures. If confirmed at sites with varying hydraulic signatures, the concept could lead to the development of a tool to help design more efficient bypass systems. Effort in 2004 will be focus on evaluating fish responses to hydraulic variables near surface bypasses at different sites.

OBJECTIVES:

1. Quantify juvenile salmonids' response to various hydraulic variables at three surface bypasses (Bonneville Corner Collector, The Dalles Ice and Trash Sluiceway, and Lower Granite Removable Spillway Weir).
2. Describe and compare the hydraulic signatures of surface bypass systems at Bonneville, The Dalles, and Lower Granite.
4. Analyze fish response data relative to hydraulic variables to determine correlations.
5. Compare fish responses between the three sites.

SCHEDULE: 2004 – 2006

Northwestern Division - Corps of Engineers
ANADROMOUS FISH EVALUATION PROGRAM
RESEARCH SUMMARY

STUDY CODE: SBE-P-0017

TITLE: Studies of Surface Flow Bypass at The Dalles Dam.

FISH PROGRAM FEATURE: CRFMP - The Dalles - Surface Flow Bypass.

BIOP MEASURE: RPAs 69 and 86

Recent research (1999-2002) indicates that between 8 and 50% of the juvenile salmon that pass The Dalles Dam (TDA), do so through turbines. Studies in 1995 and 1996 suggested that occluding the upper portion of turbine intakes might significantly reduce turbine entrainment. As a result, J-block intake occlusions were tested at TDA in 2001 and 2002 to determine if occluding the upper portion of turbine intakes might significantly reduce turbine entrainment. Results from this research indicate the J-block occlusions were not as effective at reducing turbine passage as was hoped and in some cases, even increased turbine passage. Additionally, survival of fish passing the spillway at TDA is lower relative to other projects on the lower Columbia River. Currently, efforts to improve spillway survival are being pursued at TDA. Though, regardless of the level of success in improving spillway survival at TDA, continuous efforts need to be made to minimize turbine passage.

Studies in recent years have focused on fish passage and survival at TDA, though little information on distribution and approach paths of fish entering the forebay and passing the dam exists. In 2003, a hydroacoustic study was initiated to collect general information on fish distribution (vertical and horizontal) in the forebay of TDA. Additional, detailed information on individual fish approach paths and their passage fate needs to be coupled with population level fish distribution information to get a more complete description of how juvenile salmon enter TDA forebay and pass the dam. Recent developments in integrating computational fluid dynamic (CFD) model outputs and individual fish behavior data show promise as a tool that may be useful for describing how fish are likely to respond to hydraulic and structural elements they may encounter as they approach a dam during their emigration. Pending further development of this tool, it may be useful in determining an optimal design and location of turbine passage reduction structures such as a forebay physical guidance device or powerhouse surface flow bypass system.

OBJECTIVES:

1. Estimate spill passage efficiency, sluice passage efficiency, and fish passage efficiency during spring and summer.
2. Characterize individual approach paths and determine passage fate of juvenile salmon (yearling chinook, steelhead, sockeye and subyearling chinook) within the entire forebay up to 2000’ upstream of the east end of the powerhouse.
3. Estimate vertical and horizontal fish distribution within the entire forebay up to 2000’ upstream of the east end of the powerhouse.
4. Integrate CFD model outputs of representative hydraulic conditions with fish approach path and distribution data.
5. Evaluate east (MU 17-2, 17-3, 18-1) vs. west (MU 1-1, 1-2, 1-3) sluiceway skimmer gate operation and it’s effect on fish passage through the sluiceway during the summer.

SCHEDULE: 2003 – 2007

Northwestern Division - Corps of Engineers
ANADROMOUS FISH EVALUATION PROGRAM
RESEARCH SUMMARY

STUDY CODE: SBE-P-03-NEW

TITLE: Studies of Surface Flow Bypass at John Day Dam.

FISH PROGRAM FEATURE: CRFMP – John Day - Surface Flow Bypass/Surface Spill.

BIOP MEASURE: RPAs 72, 86, 98, and 138.

Surface Flow Bypass (SFB) has been evaluated for the past several years as a means to enhance juvenile salmonid passage and survival at Corps operated hydroelectric facilities in the Columbia River Basin. Most SFB programs have focused on powerhouse passage. Though recently, much attention has focused on a removable spillway weir (RSW) installed at Lower Granite for the 2002 outmigration to provide a surface route of passage at the spillway. Results from 2002 testing indicate that the RSW was relatively efficient at passing fish during the daytime. Furthermore, fish egress out of the tailrace after passing through the RSW was direct with little increase in tailrace residence time. In 2003, additional study of RSW is underway to further describe the passage efficiency of the RSW at Lower Granite.

In recent years, the SFB program at John Day (JDA) has focused on the possible use of one or more of four skeleton bays as a high volume SFB. At the completion of the design memorandum for the skeleton bay SFB, regional fishery managers deemed the cost too high given the uncertainties in providing a safer more. The region directed the Corps to evaluate a potentially less expensive alternative to evaluate the SFB concept. The Portland District, in coordination with regional fishery managers, designed a high discharge (!8 kcfs) RSW for evaluation in 2002. However, given additional uncertainties with fish egress and condition/survival through a RSW, construction and testing were postponed until results from the LGR RSW evaluation were obtained. Recent results from LGR RSW testing are encouraging. There is some indication that a lower discharge RSW similar to the LGR RSW may provide a daytime passage route at JDA and act to reduce extended forebay residence time. Currently, there is a void of information describing fish behavior and distribution in the forebay of JDA. Detailed information on forebay distribution under different operating conditions is needed to help determine the most effective configuration and location of a surface flow bypass system at JDA.

OBJECTIVES: *(placeholder)*

1. Estimate vertical and horizontal fish distribution upstream, within 1000 m of the dam.
2. Describe hydraulic patterns upstream, within 1000 m of the dam and relate to fish distribution.

SCHEDULE: 2004 – 2006

Northwestern Division - Corps of Engineers
ANADROMOUS FISH EVALUATION PROGRAM
RESEARCH SUMMARY

STUDY CODE: ADS-00-1

TITLE: Evaluation of Adult Salmon and Steelhead Fallback at Snake and Columbia River Dams

FISH PROGRAM FEATURE: CRFMP - System - Adult Passage

BIOP MEASURE: RPAs 60, 93, 111, 112, 113, 116, 117, and 119

To understand the causes of fallback and develop solutions, we need to know what fish are most susceptible to fallback, where fallback is occurring, what are the causes of fallback, and what is the effect of fallback on adult survival to spawning. Salmon and steelhead fallback at Columbia and Snake River dams has been well documented. Rates of fish falling back over dams can reach 20% during periods of high spill. Results indicate that survival for fish that fall back at a dam is approximately 5% less than fish that do not fall back. Even when there is no spill, up to 4% of spring and summer chinook fall back at Bonneville.

Bonneville dam, the first that fish encounter on the river system has a history of higher fallback rates than other dams, especially for fish leaving the Bradford Island exit. In 2001 and 2002, with a change to powerhouse 2 priority, sp/su chinook fallback rates at Bonneville have dropped dramatically to 2% or less for near-field, 6% or less for all fallbacks.

New spillway deflectors and spill patterns are being developed to improve water quality at many of the dams on the Columbia and Snake Rivers. There are concerns over the effects on adult passage, including fallback, ladder use, and delay, arising from these modifications. In 2002, adult sp/su chinook had very low fallback rates but passage delays of 8-12 hrs were found under gas cap spill levels at Bonneville. As spill patterns and levels are being evaluated to improve juvenile survival, the effects on adults must also be taken into consideration.

OBJECTIVES:

1. Evaluate the effect of new spillway modifications and operations on the fallback routes, percentages and rates, and on fish passage delay.
    a. Bonneville Dam flow deflectors. Test gas cap vs. 75 kcfs spill 2002-2003 and evaluate one-condition spill level in 2004 for sp/su chinook and summer steelhead.
    b. The Dalles Dam. Installation of a new spill wall and concentration of spill to the north end of the spillway needs to be evaluated. 2004. 2005 if problems are discovered.
    c. McNary end bay deflectors. 2002-2003.
    d. Lower Granite RSW. 2002-2003.
    e. Little Goose end bay deflectors. 2006-2007.
    f. Lower Monumental end bay deflectors 2003. 2004 if problems are discovered.
2. Evaluate fallback at the new Bonneville Corner Collector. (2004).
3. Summarize the effects on escapement/survival of different types of fallback by project since 1996 on salmonid ESU or best surrogate.
4. Develop alternative methodology, e.g., fallback model or use of PIT tag data, that can be used to estimate fallback at Columbia and Snake River dams for ESU (or best surrogate) in future years without radiotelemetry.

SCHEDULE: 1995 – 2007

Northwestern Division - Corps of Engineers
ANADROMOUS FISH EVALUATION PROGRAM
RESEARCH SUMMARY

STUDY CODE: ADS-00-2

TITLE: Evaluation of Adult Salmon and Steelhead Delay at Snake and Columbia River Dams

FISH PROGRAM FEATURE: CRFMP - System - Adult Passage

BIOP MEASURE: RPAs 116, 117, and 119

Past and recent radio telemetry studies demonstrate that adult migrants are delayed at dams. Project passage times can range from 1 to 1174 hours. Compilation of past telemetry data show median project passage times ranging from 30 to 60 hours for Bonneville, The Dalles, and John Day dams. How migration delay affects adult salmon and steelhead survival and spawning success is not well understood. Past and recent studies point to fallback, the time to first entrance, and transition pools, as the primary areas of delay at projects. In addition, during 2002, delays of 8-12 hrs were found in sp/su Chinook at Bonneville during gas cap spill with new spill deflectors and pattern. There is concern that similar delays may occur at other projects doing similar spillway modifications.

Tests of open vs. closed orifice gates at Bonneville PH1 found no differences in passage times. Median passage times at The Dalles, Lower Monument, and Little Goose were lower during years when orifice gates were closed but differences were not significant. Overall, results since 1997 point to no negative effects from closing orifice gates. In 2003, John Day orifice passage will be evaluated.

Experimental weir modifications in the transition pool of Lower Granite reduced passage times for spring and summer Chinook (2.2 hr reduction in transition pool passage). Once a functional permanent system is installed and tested, similar modifications could be applied and evaluated at other dams where deemed necessary.

OBJECTIVES:

1. Assess the effect of transition pool modifications on migration delay.
    a. Design a permanent transition pool design at LGR to function like the test structures that reduced delays, install and evaluate. 2005-2006.
    b. Evaluate other ladders where such modifications may be applicable and of benefit.
2. Evaluate effects of new spillway modifications and operations on passage time of adult salmon and steelhead.
    a. Bonneville Dam. 2002-2003 evaluations should result in a selection of a one-condition spill in 2004 that will need to be evaluated for delay and fallback.
    b. The Dalles Dam. Installation of a new spillwall and concentration of spill to the north end of the spillway needs to be evaluated. 2004-2005
    c. If 2003 results at LOMO and MCN indicate any unexpected problems, another year of evaluations may be needed. 2004.
3. Summarize the magnitude and effects on escapement/survival of different types of delay (1996-2003) on salmonid ESU or best surrogate. 2004-2005.

SCHEDULE: 1995 - 2007

Northwestern Division - Corps of Engineers
ANADROMOUS FISH EVALUATION PROGRAM
RESEARCH SUMMARY

STUDY CODE: ADS-00-4

TITLE: Investigation of Straying in Adult Salmon and Steelhead.

FISH PROGRAM FEATURE: O&M - System - Adult Passage

BIOP MEASURE: RPAs 48, 50, 107, 118, 167, and 191

Beginning preliminarily in 2000 and full scale in 2001, fish of known origins (PIT tagged as juveniles) began to be radio-tagged and followed on their migration routes. From this work we have begun to evaluate the extent and nature of straying in detail. Straying rates in 2001 varied from 1.3% for sp/su Chinook to 7.1% for fall Chinook and 9% for steelhead. Most sp/su Chinook strays from the Snake River entered Deschutes, John Day or Little White Salmon rivers.

Straying is a natural characteristic of salmon populations that serves to colonize vacant habitat, and to increase genetic diversity. However, excessive straying can genetically swamp the locally adapted population. The hypothesis has been raised that the COE program of transporting juvenile salmonids downstream may cause increased straying. Salmon PIT tagged as juveniles above Lower Granite and detected at Bonneville in 2000 as adults reached Lower Granite in similar proportions whether or not they were transported. Seventy-three percent (91 of 124) of the adults that were transported as juveniles reached Lower Granite and 76% (54 of 71) that migrated in-river as juveniles reached Lower Granite. 2001 analyses indicate small but not significant differences in rates of straying for steelhead or sp/su Chinook that were transported or river run fish (1.0 vs. 4.2% for sp./su Chinook and 11.1 vs. 9.9% for steelhead). Data in 2002 and 2003 will also be analyzed to evaluate any effects from transport on straying.

Straying rates are an essential adjustment factor to adult survival estimates used to evaluate if the adult BIOP survival goals are being met. At present, system wide radio-telemetry is the only methodology to obtain straying rates representative of the ESUs. If straying rates cannot be modeled based on data through 2003 and no alternative means of estimating straying rates can be obtained then radiotelemetry will be the only means of obtaining this data.

OBJECTIVES:

1. Compare straying of known source fish to determine stock differences in behavior. 2000-2003
2. Evaluate the ability to model straying rates to environmental conditions to be able to estimate straying rates for BIOP survival goal estimates. 2004-2005.
3. Evaluate methods other than radiotelemetry to estimate straying rates for ESUs. 2004-2005
4. Estimate straying rates for known source ESU or ESU surrogate fish for BIOP survival goal evaluations. 2005-2009.

SCHEDULE: 2000 - 2009

Northwestern Division - Corps of Engineers
ANADROMOUS FISH EVALUATION PROGRAM
RESEARCH SUMMARY

STUDY CODE: ADS-00-5

TITLE: Temperature and dissolved gas exposure of adult salmon and steelhead migrants and the effects of water quality on survival and reproductive success.

FISH PROGRAM FEATURE: System - Adult Passage

BIOP MEASURE: RPAs 34 and 115

Adult salmon and steelhead migrating to their natal streams in tributaries of the Columbia River must pass up to eight or nine dams: four dams each in the lower Columbia and Snake rivers, and five in the mid Columbia River. Adult migrants may encounter high river temperatures or supersaturated dissolved gasses en route to their spawning grounds. High temperatures may reduce reproductive success, increase susceptibility to disease, accelerate loss of energy reserves, extend passage delay and elevate stress of adult salmon and steelhead. Exposure to high levels of supersaturated dissolved gasses can be fatal to adult salmonids. Results from depth and temperature monitoring telemetry indicate that fish usually swim at depths to avoid gas saturation and warmer water temperatures in upstream reservoirs. Preliminary evaluations of the short duration and limited volume of water released from Dworshak reservoir in 2002 found little effect on salmonid migration. In the mid-Columbia, increasing water temperatures are correlated with increased travel time in the Bonneville pool. Steelhead will delay in cooler tributaries effectively reducing body temperatures. Preliminary evaluations point to an increase in escapement for steelhead using these cool water refugia but not for fall chinook.

The final year of most of the temperature evaluations was postponed in 2003 and is planned to be completed in 2004.

OBJECTIVES:

1. Determine whether cool water releases from Dworshak affect migration patterns of adult salmon and steelhead. 2002-2004
    a. Evaluate fish passage time changes in the Snake River in relation to cool water releases from Dworshak reservoir by comparing among years with alternative water release regimes.
    b. Determine migration routes of summer and fall chinook and steelhead that are tagged with radio-transmitters as they travel above Lower Granite Dam to tributary mouths.
    c. Determine whether migration routes are associated with cool water corridors.
2. Determine whether exposure to elevated river temperatures is related to reduced escapement to a spawning stream.

SCHEDULE: 2000 - 2004

Northwestern Division - Corps of Engineers
ANADROMOUS FISH EVALUATION PROGRAM
RESEARCH SUMMARY

STUDY CODE: ADS-00-6

TITLE: Evaluation of Kelt Passage through Columbia and Snake River Dams.

FISH PROGRAM FEATURE: O&M - System - Adult Passage

BIOP MEASURE: RPA 109

Unlike chinook, sockeye and coho salmon, steelhead trout may spawn more than once during their lifetime. In the Columbia Basin, post-spawn steelhead (kelts) must first pass up to nine dams on their return to the ocean. Ultrasonic identification and enumeration work estimated 80% to 90% of the steelhead passing through the Lower Granite and Little Goose juvenile fish facilities are kelts. By tagging kelts and monitoring their migration downstream through the FCRPS, we are gaining a better understanding of routes of passage and survival of kelts. This information is needed to develop effective protection measures for these fish. Results in 2001during spill periods (30% spill at The Dalles and 37% at Bonneville) indicate project passage efficiencies of 99% at The Dalles and 84% at Bonneville. Passage efficiency at Bonneville including non-spill periods dropped to 68%. Installation of the corner collector at Bonneville second powerhouse is expected to increase passage efficiency and will be evaluated in 2004. Spilling water significantly reduced the travel and passage times of kelts through the projects and pools in the lower Columbia. Kelt studies continue to indicate that river run Snake River kelts do not survive well (<5% reach below BON) but that fair and good condition lower Columbia PIT-tagged Kelts return at rates of nearly 8%. Reconditioning and rematuration rates in excess of 25% have been achieved with wild summer steelhead on the Yakima River. It is hoped that a system wide strategy for the management of steelhead kelts can be formulated after the 2004 research season

OBJECTIVES:

1. Enumerate downstream kelt passage and run timing through the Snake and Columbia rivers. 2001-2004.
2. Determine passage routes, distribution and survival through each route for kelts. 2001-2004.
3. Evaluate system survival (Lower Granite to McNary and to Bonneville dams, etc.). 2001-2004.
4. Monitor fish condition and collect scale or fin ray samples to determine life history information from individually tagged kelts. (every year of field work).
5. Investigate and evaluate protection measures, including operational changes, collection and downstream transportation, and/or collection and reconditioning in a fish culture facility. 2002 – 2004.
6. Evaluate returns of kelts and compare returns of transported and river run PIT tagged Kelts. 2002-2004.
7. Evaluate the survival of reconditioned fish at an appropriate location on the Snake River system. 2004-2005

SCHEDULE: 2000-2005

Northwestern Division - Corps of Engineers
ANADROMOUS FISH EVALUATION PROGRAM
RESEARCH SUMMARY

STUDY CODE: ADS-P-00-8 (formerly MPE-99-1)

TITLE: Development of Alternative Means to Pass Adult Pacific Lamprey Around Dams

FISH PROGRAM FEATURE: CRFMP - System - Adult Passage

BIOP MEASURE: Pacific lamprey are petitioned to be listed under the Endangered Species Act.

There is significant regional concern regarding lamprey populations in the Columbia Basin. In 1993, the Oregon Department of Fish and Wildlife designated Pacific lamprey at risk of being listed as threatened or endangered. The U.S. Fish and Wildlife Service designated Pacific lamprey as a Category 2 candidate species in 1994. The Northwest Power Planning Council's (NPPC) 1994 Fish and Wildlife Program acknowledged the apparent decline of Pacific lamprey and requested a status report to identify research needs. Columbia River treaty tribes have repeatedly voiced concern about the decline of Pacific lamprey, a culturally important species.

Radio telemetry data indicate adult lamprey have a low passage success rate at Bonneville Dam (only up to half the fish released below the dam successfully pass). Passage rates at The Dalles Dam are considerably higher (up to 82%) and rates at John Day Dam are intermediate. These data also identify entrances, entrance pools, and serpentine weirs as the primary obstacles to lamprey passage. In 2000 and 2001 we evaluated the effect of rounded entrance corners, floor diffusers, count stations, lighting, and entrance head on lamprey passage. We found that diffuser gratings affected lamprey passage but lighting did not. Ladder passage improved when steel strips or runways over part of the diffuser gratings were provided for lamprey to attach to. We also made some minor modifications to the surfaces around one spillway entrance, and this seemed to improve passage success. The goal of this program is to develop upstream migrant facilities at Bonneville that will pass adult pacific lamprey without disrupting adult salmon and steelhead passage. In 2002 passage rates at Bonneville dam increased to nearly 50% and preliminary tests of the prototype passage structure n the AWS channel in the Bradford Island ladder passed up to 33 lamprey/night. Evaluations of prototype systems will continue in 2003.

OBJECTIVES:

1. Evaluate modifications to adult fishways that would pass Pacific lamprey.
    a. Evaluate rounding of right angle corners. 2000-2002.
    b. Evaluate plates over gratings. 2000-2002.
    c. Evaluate counting window area 2001-2002.
    d. Evaluate prototype auxiliary passage system. 2002-2005.
2. Assess the effect of modifications on adult salmon and steelhead passage. All years.
3. Install and evaluate auxiliary passage system at Bonneville Dam if deemed effective and necessary. (Placeholder)

SCHEDULE: 1999 - 2005

Northwestern Division - Corps of Engineers
ANADROMOUS FISH EVALUATION PROGRAM
RESEARCH SUMMARY

STUDY CODE: ADS-00-13

TITLE: Effects of Dam Passage on Survival and Reproductive Fitness of Adult Salmon and Steelhead

FISH PROGRAM FEATURE: CRFMP – System – Adult Passage

BIOP MEASURE: RPA 118

Adult salmon and steelhead migrating to their natal streams in tributaries of the Columbia River must pass up to eight or nine dams: four dams each in the lower Columbia and Snake rivers, and five in the mid Columbia River. While studies have documented direct mortality due to factors such as fallback at these dams, little is known regarding delayed effects of dam passage on adult migrant survival and reproductive success. Excessive energy expenditure and exposure to adverse water quality are elements of dam passage that may have a delayed effect on adult salmon and steelhead survival and reproductive fitness. Preliminary EMG data indicate that the tailrace is the area of highest energy use, followed by the ladder, and the forebay.

Understanding the spawning success of specific stocks with known passage histories (using radio telemetry and/or PIT tagged fish) can help determine the effects of dam passage on salmon return and reproductive success. Targeting additional PIT tagging efforts on specific stocks that can later be evaluated for passage history and spawning success and instigating the use of PIT tag readers by carcass survey crews should be initiated.

OBJECTIVES:

1. Evaluate potential effects of different upstream migratory passage histories on survival and reproductive success of know source fish. 2002-2009.
    a. Evaluate if fallback and/or delay relate to spawning success and energy reserves
    b. Assess the effect of high water temperatures on energy expenditure, survival, and reproductive success.
2. Evaluate energy reserves of upstream migrating fish as they enter the hydrosystem at Bonneville Dam and at different stages of migration. 2002 and *Placeholder*
    a. Develop a non-lethal means to estimate energy reserve to allow repeated evaluations of individual fish along their migration path.
3. Implement targeted PIT tagging efforts that will enable future evaluations of spawning success of known history fish. 2003-2009.

SCHEDULE: 2000 – 2009.

Northwestern Division – Corps of Engineers
ANADROMOUS FISH EVALUATION PROGRAM
RESEARCH SUMMARY

STUDY CODE: ADS-00-14 *Placeholder*

TITLE: Adult Salmonid Behavior and Passage Routes Within Adult Fishways Associated with the Adult PIT Tag Evaluations Program.

FISH PROGRAM FEATURE: CRFMP - Bonneville

BIOP MEASURE: RPA 50

Per the National Marine Fisheries Service (NMFS), Biological Opinion the Portland District, Bonneville Power Administration, and NMFS have undertaken an adult PIT tag monitoring research and development program. In 1999 & 2000, several underwater orifices within adult fishways at the Bonneville project were modified to install developmental PIT tag readers. Further, the Corps and NMFS are undertaking a hydraulic modeling program to better evaluate hydraulic conditions associated with these and other possible modifications to adult fishways to insure proper fish passage conditions. It will be necessary to also study fish passage behavior and timing during the development of this monitoring technology. Work in 2001 discovered that large numbers of fall fish swam over all 8 overflow weirs in a row and missed all the orifice detectors. New strategies for locating additional detectors at counting stations and vertical slots are being pursued. A slot-detector system at a McNary counting station and orifice detectors in all the Bonneville and McNary ladder will be installed in 2002. Future underwater video evaluations of new detection system may be necessary. In 2002 we will continue the video evaluation of adult salmonid behavior associated with underwater orifice passage, and passage over the overflow weirs. This work will be conducted with BPA funded fish studies of efficiency for passage through underwater orifices outfitted with PIT tag detection antenna and transceivers.

OBJECTIVES:

1. As PIT tag detection system develops and expands video evaluations of new locations of detectors may be needed. Placeholder for 2004-2005.

SCHEDULE: 2000- 2005.

North Pacific Division - Corps of Engineers
ANADROMOUS FISH EVALUATION PROGRAM
RESEARCH SUMMARY

STUDY CODE: ADS-02-16 *(Placeholder awaiting a low run year or decision on suitable management action).*

TITLE: Evaluation of Sea Lion Predation Below Bonneville Dam

FISH PROGRAM FEATURE: O&M - System

BIOP MEASURE: RPA 106

Many salmonids enter the Columbia River system with marine mammal wounds. Some additional predation occurs at Bonneville Dam, where sea lions have been observed each spring for many years. The Oregon Department of Fish and Wildlife (ODFW) found that 36.5% of a sample of 203 steelhead observed at Bonneville Dam in 1994 had marine mammal injuries. At Lower Granite Dam, marine mammal bite marks have been monitored since 1990, and spring and summer chinook injury rates were 19.2%, 14.0%, 15.0%, and 18.3% for 1990-93. The proportion of these injuries attributable to sea lions in Bonneville Dam's tailrace is unknown. Also, little is known about the effect marine mammal injuries have on adult migrant survival or spawning success. U of Idaho telemetry work from 1996-98 found that adult sp/sum chinook with marine mammal marks were not more likely to be unaccounted for. In 2002, 30 different individual sea lions have been identified either by colored tags or numerals or scars and markings. Several of these marked sea lions were captured and marked near Astoria. Large adult males seem to be the most successful at catching fish. The most individuals detected in the tailrace at one time was 7-8. Animals leave the vicinity of the dam at night. The sea lions consumed an estimated 0.54% of the run while they were at the dam (March 21 – May 17, 2002). Early results from 2003 indicate a larger number of sea lions in the tailrace along with an increase in overall consumption. What the eventual management actions will be once good estimates of the consumption rate are yet to be determined.

OBJECTIVES:
1. Analyze existing and future adult telemetry data to determine the extent of injury and death to tagged fish from predation by marine mammals in Bonneville's tailrace.
2. Determine seasonal timing and numbers of sealions present at Bonneville Dam.
3. Estimate sealion consumption of adult salmonids at Bonneville Dam.
4. Identify individual sealions at Bonneville Dam, determine whether they return in subsequent years, and their haul out areas.

SCHEDULE: 2002-2003

NOTE: Area of interest at Bonneville Dam is the tailrace boating restricted zone.

North Pacific Division - Corps of Engineers
ANADROMOUS FISH EVALUATION PROGRAM
RESEARCH SUMMARY

STUDY CODE: ADS-04-NEW

TITLE: White Sturgeon Passage at Lower Columbia River Dams.

FISH PROGRAM FEATURE: CRFMP - System

BIOP MEASURE: This evaluation addresses FWP Measure 10.4A.2 – Determine the impacts of the hydrosystem on sturgeon.

Although the white sturgeon fishery below Bonneville Dam is one of the most productive in the world, populations in the upstream reservoirs are affected by a reduction in swift-water spawning habitats and limited upstream and downstream movements of both sturgeon and 2 of their major prey species. Beginning in the 1980s the *White Sturgeon Mitigation and Restoration in the Columbia and Snake Rivers* and *Assessing Genetic Variation Among Columbia River Basin White Sturgeon Populations* projects are working to protect and restore white sturgeon populations and to mitigate for effects of the hydropower system. Among the methods being used are habitat and population studies, harvest management, artificial propagation, and transplant of juvenile fish from below Bonneville to upstream reservoirs. Improving passage for sturgeon at dams is an important part of future actions needed to help restore and maintain white sturgeon populations.

OBJECTIVES:

1. Evaluate upstream and downstream passage of white sturgeon at FCRPS dams in the lower Columbia River.
    a. Evaluate passage/movements of adults in the east ladder at The Dalles Dam. 2004 –2006.
    b. Evaluate fishway designs to facilitate upstream passage of breeding age adults and downstream passage of juvenile fish. 2006-2007.
2. Evaluate operations that may negatively effect survival, passage, and spawning success of sturgeon in vicinity of dams.

SCHEDULE: 2005-2007

NOTE: Areas of interest are the lower Columbia River dams.

Northwestern Division- Corps of Engineers
ANADROMOUS FISH EVALUATION PROGRAM
RESEARCH SUMMARY

STUDY CODE: ADS-P-04 - NEW

TITLE: Evaluation of John Day Dam South Fish Ladder Modifications

FISH PROGRAM FEATURE: CRFMP-In-river Passage

BIOP MEASURE: RPA 110

Jumping behavior by adult salmonids in the fish ladders of John Day Dam has been a problem since initial construction of the fishways in the late 1960's. Since 1968, fishway inspectors and others have documented more than 109 mortalities attributed to fish jumping out of the ladder. The actual number is undoubtedly higher, as exact numbers were not always documented or reported. Protective netting placed over the north and south fish ladders over the years and most extensively since 1993 has not eliminated mortality entirely.

Since 1993, the Fish Field Unit (FFU) has conducted jump evaluations in the fishways of John Day Dam. These studies have focused on salmonid jump behavior in the vertical slot/flow control section of the fishways where the predominant jumping occurs. Water quality factors (pH, conductivity, dissolved oxygen, and turbidity), temperature, shading along the catwalk, and jump behavior during different times of the day have been examined. These studies have determined that peak jumping occurs a few weeks after peak migration, and that steelhead generally exhibit the highest percentage of jumping behavior. It has been determined that jumping occurs primarily in the fall (September and October), and most frequently in the first four pools on the south side of the vertical slot section above the upper diffuser #5 in the south ladder. In 2000, an experimental slot/orifice was cut into a baffle upstream of a pool where high jump rates (jumps/hour) have been observed over the years. The purpose of the test was to see if providing a direct upstream exit to a pool would reduce or eliminate jumping behavior in that pool. The experimental slot was designed so that the ladder could operate with it open or closed. A paired test was conducted in 2000 and 2001 to compare jump rates with the slot and or orifice open versus closed. Results from 2000 showed a significant jump rate reduction with the slot open ((3.2 jumps/hour) versus the existing configuration (13.6 jumps/hour) (Jonas and Madson 2001). The 2001 study outcome was similar, but the overall jump rates were lower (2.8 jumps/hour treatment vs. 4.9 jumps/hour control) (Jonas and Madson 2002). The observed differences were statistically significant. The 2000 and 2001 results suggest that a change in baffle geometry would result in a reduction of fish jumping in the south ladder. The baffle geometry most similar to the configuration tested in 2000 and 2001 exists at The Dalles north shore fishway and at Snake River projects operated by the Corps of Engineers. Fish readily pass through the flow control sections of these ladders with no notable problems, such as jumping.

In 2002 – 03, the COE will replace existing baffles in the south ladder flow control section with a new baffle design similar to that of The Dalles Dam north shore fishway. Post-construction evaluation of this new design will occur in 2003 and 2004.

OBJECTIVES:
1. Estimate the jump rate by adult salmonids in the flow control section.
2. Estimate passage times from the upper diffuser (Diffuser 5) to the exit.
3. Estimate upstream to downstream passage ratios at the south ladder count station.

SCHEDULE: 2003 - 2004

North Pacific Division - Corps of Engineers
ANADROMOUS FISH EVALUATION PROGRAM
RESEARCH SUMMARY

STUDY CODE: BT- *(Placeholder awaiting adequate population to study)*

TITLE: Bull trout passage at lower Columbia River dams.

FISH PROGRAM FEATURE: O&M - System

BIOP MEASURE: This evaluation is included under Reasonable and Prudent Measures – Bull Trout in the USFWS Biological Opinion 10.A.2 Lower Columbia River.

Bull trout (*Salvelinus confluentus)* were once abundant in the Columbia River basin. Population levels have declined in some areas, raising concerns about the long-term sustainability of the species. In 1998, Columbia River bull trout were listed as "threatened" under the Endangered Species Act. Bull trout require cold, clear water, thus, most of their historic records and the majority of research efforts are in tributaries. There is little information on historic and current use of the main stem Columbia River and dam passage. USFWS has just finished compiling a Columbia Basin wide survey of historical and current bull trout information and research that will be published in the Congressional Record in October 2002.

OBJECTIVES:

1. If sufficient numbers of bull trout are available in the lower Columbia River, evaluate the movements and habitat use of bull trout in the lower Columbia River reservoirs and in the vicinity of dams. 2004-2005.

SCHEDULE: 2003-2007.

NOTE: Areas of interest are the lower Columbia River dams and reservoirs.

Northwestern Division - Corps of Engineers
ANADROMOUS FISH EVALUATION PROGRAM
STUDY SUMMARY

STUDY CODE: EST-02-01

TITLE: A Study To Estimate Salmonid Survival Through The Columbia River Estuary Using Acoustic Tags

FISH PROGRAM FEATURE: CRFMP – Estuary Program

BIOP MEASURE: Reasonable and Prudent Alternative (RPA) 195 requires the Corps to evaluate survival of fish passing through the FCRPS below Bonneville dam, which will include the estuary. The Columbia River estuary is an important transition habitat to outmigrating juvenile salmon. Recent evidence suggests that improvement in survival of the estuarine and early ocean life history phase of Columbia River salmon may be critical to the recovery of endangered stocks. Survival success of Columbia River salmon hinges on the complex interaction of smolt quality and the abiotic and biotic ocean conditions at the time of entry and during their first year of ocean residence. Factors that potentially affect age-class recruitment during the first months of ocean residency include fish size and health status at the time of entry, entry timing, and ocean conditions during the first months. These factors are influenced or controlled by several aspects of the Columbia River estuary: differences in life history strategies, river flow (hydropower system management), and estuarine habitat availability and quality. Therefore, it is important to understand how salmonids use the estuary, both spatially and temporally, and how different ESUs, life history types, and various rearing, passage, and condition histories use and benefit from the estuary, and how these conditions affect ocean entry and survival. Development of micro-acoustic transmitters would enable their use in the estuary environment for both ocean- and stream-type salmon. This would allow the following hypotheses to be evaluated a) interannual, life history (ocean- and stream-type), and biological (size/age) differences impact estuarine habitat selection and residence time, b) residence may vary within season, and c) estuarine habitat use is patchy, not uniform, and salmonids key on specific habitat features. Spatial and temporal observations of fish utilization of the estuary habitat are needed that link back to the variables described above, to develop hydropower management scenarios that benefit survival, growth, and health of juvenile salmon in the Columbia River estuary and their entry into and survival in the nearshore ocean environment.

OBJECTIVES:

1. Develop an acoustic tag that is small enough to use in ocean-type juvenile salmonids. Research and development is needed in the following areas.
    a. Continue work on minimizing tag by reducing size, weight, and volume for use in ocean-type salmonids.
    b. Investigate new battery and transducer technologies to support the downsizing engineering effort.
2. Analyze the acoustic environment at the mouth of the Columbia River and develop appropriate detection arrays to monitor juvenile timing and behavior through the estuary. Prototype test and deploy the detection array and monitoring software.
3. Evaluate biological effects of tag coatings and tag effects on fish growth and behavior.
4. Using the single-release statistical model estimate survival from Bonneville Dam to the mouth of the Columbia River for target groups of various ESUs, and rearing, transportation, hydropower system passage histories (2003-2005). Compare survival through the estuary for various target groups evaluated.
5. Develop mobile tracking techniques to identify preferred estuary habitat types and monitor and estimate small-scale behaviors relative to these habitats to support estuary habitat restoration activities. Integrate findings with results from other COE and BPA funded estuarine habitat studies to link habitat use behaviors to growth, benefits, and survival into the nearshore marine environment.

SCHEDULE: 2000-2008

Northwestern Division - Corps of Engineers
ANADROMOUS FISH EVALUATION PROGRAM
STUDY SUMMARY

STUDY CODE: EST-02-02

TITLE: Estuarine Habitat And Juvenile Salmon – Current And Historic Linkages In The Lower Columbia River And Estuary

FISH PROGRAM FEATURE: CRFMP - Estuary

BIOP MEASURE:

Understanding how juvenile salmon use of the Columbia River estuary in regards to rearing is vital to understanding the factors that effect their survival. Little information is available on which habitats are important, why they are important, and how they are used and for how long. This research will provide information that can be used to answer these questions.

OBJECTIVES:

1. Continue monthly monitoring of use of estuarine habitat by juvenile Salmon
2. Continue developing linkages between juvenile salmon and habitat attributes that determine juvenile salmon use and performance in estuarine habitats. The first year's focus has been on tidal and forested wetlands, however, it will be prudent to evaluate all potential habitat types for use and ESU fitness.
3. Continue development of a GIS-based salmon habitat map of the lower Columbia River and estuary (2002-2004)
4. Continue developing monitoring stations to continuously measure the physical oceanographic environment in support of the biological studies in the Columbia River estuary
5. Further refinement of the historical database of flows and sediment input into the lower river and estuary (this will be completed during the second year)
6. Initiate studies to characterize the role of sediment input into the estuary as a factor affecting habitat creation and use and performance (growth) of juvenile salmon of estuarine habitat in the lower Columbia River and estuary
7. Develop a 3-dimensional model of the lower Columbia River and estuary that will be used to evaluate the historical, current and future habitat opportunity for juvenile salmon.

SCHEDULE: 2000-2008

Northwestern Division - Corps of Engineers
ANADROMOUS FISH EVALUATION PROGRAM
STUDY SUMMARY

STUDY CODE: EST-02-03

TITLE: Evaluation Of The Relationship Among Time Of Ocean Entry, Physical, And Biological Characteristics Of The Estuary And Plum Environment And Adult Return Rates.

FISH PROGRAM FEATURE: CRFMP-Estuary

BIOP MEASURE:

This study will examine the relationship among time of salmonid ocean entry, physical and biological characteristics of the Columbia River estuary and nearshore plume environment, and smolt-to adult return rates (SARs) for yearling chinook and/or coho salmon.

OBJECTIVES:

1. Estimate smolt-to-adult-returns of serially released yearling chinook and/or coho salmon through the spring migration period.
2. Characterize variations in the physical and biological conditions in the Columbia River estuary and nearshore ocean environment during this time period.
3. Determine the level of physiological development and disease status of smolts at release.
4. Correlate SARs with environmental conditions.
5. Identify potential indicators (biotic, abiotic, or a combination of both) of salmonid marine survival that could be used to improve management actions.

SCHEDULE: 2000-2006

Draft Proposal for One-pager for Adult Studies for the Estuary/Plume
February 26, 2003
Cathy Tortorici

STUDY CODE: EST-04-NEW

TITLE: Evaluate Adult Salmon Habitat Use in the Columbia River Estuary and Plume

FISH PROGRAM FEATURE:

Information on adult salmon distribution and usage of the estuary and plume environments is limited to rough estimates of run timing and a limited number of telemetry studies. Data from these studies describe the movements of small numbers of individuals over relatively short distances. More detailed information on adult use is needed to identify ESA-listed species and runs that may be impacted, either directly or indirectly, by hydropower management (flow augmentation). This information can then be used to determine appropriate measures to minimize impacts to salmon migration, behavior, and survival, as well as aid in habitat restoration and recovery efforts.

BIOP MEASURES: This evaluation is included under Reasonable and Alternative Actions 196 and 197 in the NMFS 2000 Biological Opinion for Operation of the Federal Columbia River Power System.

OBJECTIVES:

1. Determine the temporal and spatial patterns of habitat use in the estuary and plume environments by ESA-listed adult salmon during their upstream migration. This assessment would include documentation of adult salmon habitat use over both small and large spatial scales.
2. Based on this initial assessment effort, determine if further work needs to be completed.

SCHEDULE: 2004-2006

North Pacific Division – Corps of Engineers
ANADROMOUS FISH EVALUATION PROGRAM
RESEARCH SUMMARY

STUDY CODE: EST-04-NEW

TITLE: Evaluating cumulative ecosystem response to restoration projects in the Lower Columbia River and Estuary

FISH PROGRAM FEATURE: CRFMP -- Estuary

BIOP MEASURE: In Action 160 of the Reasonable and Prudent Alternative of the Biological Opinion on operation of the Federal Columbia River Power System (December 2000), the National Marine Fisheries Service stated, "*The Corps and BPA, working with LCREP, shall develop and implement an estuary restoration program with a goal of protecting and enhancing 10,000 acres of tidal wetlands and other key habitats…Action Agencies shall provide planning and engineering expertise to implement the non-Federal share of on-the-ground habitat improvement efforts...*" The types of restoration activities under consideration in the long-term plan for estuarine restoration might include the following: reconnect backwater channels, sloughs and oxbows through dike removal; recovering estuarine wetlands through removal of dikes and floodgates and filling of ditches; reconnecting upland drainages and freshwater inflow through removal of armored channels, culverts, diversions, and other channelizing structures; removing intertidal fills and piling fields; allowing natural accumulation of large woody debris; placement of dredged material; and, removing armor from shorelines. The vision for the lower Columbia River and estuary is to restore ecosystem functions. However, based on present information, there is little basis to evaluate whether the proposed actions will have a net cumulative benefit to ecosystem health and functionality. True ecosystem restoration requires that these changes be reversed to a *measurable degree*. Although it is relatively straightforward to measure area of habitat restored, we do not have any formal method for quantifying whether restoration of habitats will have a measurable cumulative effect on the health and functionality of the ecosystem. ***Restoration actions in the Lower Columbia River represent a unique opportunity to develop and employ science-based, defensible methods to evaluate the potential cumulative gains in restored ecosystem function provided by a suite of restoration projects in the system.*** The proposed work will quantify the cumulative improvements associated with restoration projects and to lay the foundation for the evaluation of the effectiveness of the restoration activities undertaken.

GOAL: Provide objective methods to predict and evaluate the cumulative response of ecosystem functions to restoration actions in the Lower Columbia River and estuary.

OBJECTIVES:

1. Develop the empirical basis for a cumulative assessment methodology.
2. Develop a set of metrics to evaluate cumulative effects of restoration projects.
3. Develop a framework for predicting the cumulative effects of individual restoration projects.
4. Develop and implement field evaluations for measuring ecosystem response to restoration projects.
5. Develop a data acquisition, and data management system to acquire, analyze, display and disseminate data on performance.
6. Develop an adaptive management system for evaluating data and making decisions to improve ecosystem functions through changes to existing and proposed restoration projects.

SCHEDULE: 2004-2010